

LOS
ANGELES
COUNTY
MUSEUM

CONTRIBUTIONS IN SCIENCE

NUMBER 76

DECEMBER 30, 1963

A REVIEW OF THE FISHES OF THE GENUS
PLEURONICHTHYS

509.73
C2 L868

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DAVID K. CALDWELL
Editor

A REVIEW OF THE FISHES OF THE GENUS *PLEURONICHTHYS*

By JOHN E. FITCH¹

ABSTRACT: The genus *Pleuronichthys* is confined to the north Pacific. Five of the six species, *coenosus*, *decurrrens*, *verticalis*, *ritteri*, and *ocellatus*, inhabit American coastal waters, and *cornutus* lives along Asiatic shores. All members of this specialized genus, commonly called turbot, are characterized by having the dorsal fin originating on the blind side.

In this review, more than 5,700 individuals were examined and identified. A key was constructed for distinguishing the species, and variations and relationships are discussed.

Each species is illustrated with a photograph and its distinguishing characters, color, geographic distribution, maximum size, food, and synonymy are outlined. In addition, various life-history aspects are discussed where information was available.

The hornyhead and Asiatic turbot (*verticalis* and *cornutus*) appear to be the most highly specialized, and the C-O turbot (*coenosus*), the most primitive.

In the eastern north Pacific, flatfishes of the genus *Pleuronichthys* (turbot) are relatively unexploited and probably represent one of California's most abundant shallow-water bottomfish resources. They are small fishes, seldom exceeding a foot in length or a pound in weight, yet they are tasty and firm of flesh. Only during the past decade have they been marketed in any quantity, and then primarily for mink food (Best, 1959).

One reason such low tonnages have been harvested probably lies in the fact that most turbot inhabit shallow water within three miles of shore, where commercial trawling is prohibited by law. Because of their relatively small sizes and small mouths, few are either fished for or hooked by sport fishermen.

Because our expanding human population has reached the point where we can no longer afford to waste protein resources by under-harvesting them, it was deemed advisable to learn as much as possible about the turbot in our waters. Immediately a major obstacle, proper species identification, presented itself. To overcome this obstacle, I undertook the present study, which includes all the turbot of the world.

MATERIAL AND METHODS

Since 1955, when I first became interested in the genus *Pleuronichthys*, I have, with assistance from my co-workers, examined, identified, and measured over 5,700 individuals. Most of these were weighed, and their sexes were

¹Research Associate, Los Angeles County Museum; Research Director, California State Fisheries Laboratory, Terminal Island. This is an expanded version of a thesis originally submitted in June 1963 in partial fulfillment of the requirements for the degree of Master of Arts in Zoology at the University of California, Los Angeles.

TABLE 2
Vertebral Counts for the Species of *Pleuronichthys*

Species	Precaudal Vertebrae					Caudal Vertebrae							Total Vertebrae							
	12	13	14	15		22	23	24	25	26			34	35	36	37	38	39	40	41
<i>ritteri</i>	24	1				5	19	1					4	20	1					
<i>ocellatus</i>	24	1				10	15						9	16						
<i>coenostus</i>	1	24						7	16	2						7	17	1		
<i>verticalis</i>		25					17	7	1						17	7	1			
<i>cornutus</i>	11	14					4	16	5						11	13	1			
<i>decurrens</i>			23	2			1	13	11						1	12	11	1		

TABLE 3
Gill Raker Counts for the Species of *Pleuronichthys*

Species	Total Gill Rakers									
	8	9	10	11	12	13	14	15	16	17
<i>cornutus</i>	5	14	6							
<i>verticalis</i>		1	11	13						
<i>decurrens</i>		2	10	12	1					
<i>ocellatus</i>			4	6	11	3	1			
<i>coenosus</i>				2	6	9	7	1		
<i>ritteri</i>					1	5	11	6	1	1

determined. In addition, numerous biological and ecological observations have been made on Californian members of the group, and 314 specimens (50 *ritteri*, 58 *coenosus*, 50 *decurrens*, 54 *verticalis*, 52 *ocellatus*, and 50 *cornutus*) were selected for use in evaluating the various species (Tables 1-4). I have examined material from throughout the known geographic ranges of the six species involved, except for *decurrens* and *coenosus*. I did not see any *decurrens* or *coenosus* from the northernmost limits of their range.

All measurements were made on the ocular side and generally follow the standardized methods of Hubbs and Lagler (1958). *Body height* involves the greatest straight-line distance between the ventral and dorsal contours exclusive of the fin rays. *Head length* was measured from the tip of the upper jaw to the posterior extremity of the bony operculum. The *interorbital ridge length* was measured in a straight line from the anterior edge or tip of the anteriormost protuberance or spine to the posterior edge or tip of the posteriormost (3rd) protuberance or spine.

Fin ray, gill raker, and pored scale counts were made with the aid of a binocular dissecting scope at low power. Generally, if the dorsal fin ray count was high, the anal ray count on the same fish also would tend to be high, regardless of fish length. This was true for all six species. The scales of *Pleuronichthys* are covered to various depths by integument, and because of this, are probably one of the least accurate (and thus least reliable) of the counts that can be made.

Vertebral counts were made either by skeletonizing fresh material or by X-raying preserved material. Both methods yield satisfactory and accurate results.

The synonymy of each species is limited to those references which are of value in understanding its taxonomy, systematics, distribution, or ecology.

SYSTEMATIC ACCOUNT

Norman (1934) distinguishes *Pleuronichthys* from other genera in subfamily Pleuronectinae by the small mouth (maxillary on ocular and blind sides less than $\frac{1}{3}$ head); by the small, acute jaw teeth, better developed on the blind side; by the thick lips with transverse plicae; by the dorsal origin

TABLE 4
Ranges of Selected Measurements (Per Mille of Standard Length)
for the Species of *Pleuronichthys*

Measurement	<i>cornutus</i>	<i>verticalis</i>	<i>decurrens</i>	<i>coenosus</i>	<i>ocellatus</i>	<i>ritteri</i>
Standard length (mm)	71-199(25) ‡	168-294(25) ‡	154-226(25) ‡	156-242(25) ‡	35-184(25) ‡	157-225(25) ‡
Total length	1260-1296(24)	1232-1292(24)	1242-1298(25)	1233-1319(25)	1230-1308(25)	1275-1325(24)
Head length	215-250(24)	221-272(25)	242-279(25)	226-272(25)	221-272(25)	214-241(24)
Bony upper orbit*	072-091(25)	068-097(25)	083-104(25)	080-098(25)	085-109(25)	063-081(25)
Maxillary length	046-060(23)	051-067(24)	056-070(25)	057-071(25)	050-065(23)	050-066(25)
Interorbital ridge length †	073-103(23)	073-100(25)	076-097(25)	077-100(25)	085-106(24)	058-077(24)
Head width at mid-orbit	075-097(25)	076-102(25)	086-105(25)	077-105(24)	078-098(25)	065-081(24)
Snout to anal fin insert	298-338(10)	349-393(5)	368-398(5)	321-338(2)	330-386(21)	340-413(15)
Snout to pectoral insert	222-252(10)	250-291(5)	258-279(5)	236-252(2)	233-274(22)	234-262(15)
Snout to pelvic insert	219-267(10)	262-295(5)	258-277(5)	245-252(2)	248-304(22)	242-286(15)
Body height	483-556(23)	451-528(25)	524-590(25)	479-527(24)	475-586(25)	505-570(24)
Caudal peduncle height	112-135(23)	107-132(25)	110-128(25)	112-142(25)	114-146(25)	099-128(25)
Pectoral fin length	122-148(24)	123-156(25)	141-182(25)	147-180(25)	122-170(23)	120-167(25)
Pelvic fin length	077-102(24)	069-097(25)	088-115(25)	076-105(25)	087-120(24)	077-100(25)

* horizontal axis

† first to third protuberance

‡ number of specimens measured appears in parens.

being on the blind side; and by the supratemporal branch of the lateral line with a long posterior prolongation. In the several hundred specimens that I examined critically, these generic characters held true without exception.

Fossil Record

Jordan and Gilbert (1920) described several fossil flatfishes from the California Miocene (Lompoc), including *Zororhombus veliger*. David (1943) designated Jordan's *Zororhombus* as a subgenus within *Pleuronichthys*. She based her opinion upon published records and one "fine specimen" in the California Institute of Technology collection (now in the Los Angeles County Museum collection). The characters she used to distinguish the subgenus *Zororhombus* (larger number of precaudal vertebrae, larger mouth, and deeper body than for any living species) are of such magnitude they cast doubt upon the validity of placing Jordan's *veliger* in the genus *Pleuronichthys*. None of the living species of *Pleuronichthys* has more than 26 caudal vertebrae (Table 2), *veliger* has 29. Similarly, no living *Pleuronichthys* has fewer than 12 precaudal vertebrae, *veliger* has 11. David (1943) states for *veliger*, "mouth 2 in head on ocular side," yet Norman (1934) characterizes the genus *Pleuronichthys* with the statement, "maxillary on ocular side less than $\frac{1}{3}$ head," which agrees with the information I obtained by measuring these characters on 150 specimens representing the six known living species (Table 4).

My examination of over 10,000 fossil otoliths (mostly in the Los Angeles County Museum collections) from one Eocene, four Pliocene, and eleven Pleistocene deposits of southern California has failed to turn up a single otolith of *Pleuronichthys*.² Species that are now associated with turbot ecologically are in profusion among these deposits, but there are no turbot. *Pleuronichthys* otoliths (sagittae) resemble rice grains in size and shape, and it would be impossible to overlook or fail to recognize them. Many tiny otoliths, 1 or 2 mm. in greatest dimension, from gobies, *Lepidogobius lepidus*, and sanddabs, *Citharichthys stigmaeus*, are among the screenings, so the larger *Pleuronichthys* otoliths, if they were present, would also be retained.

Based upon a few otoliths from a Californian deposit (Rose Canyon, San Diego county), flatfishes were present in the north Pacific during the Eocene. Several authors (Gilbert, 1910; Jordan and Gilbert, 1919 and 1920; Jordan, 1924) described fossil flatfishes from diatomaceous Miocene deposits of southern California, but none of these is congeneric with any flatfish living off our coast today. There is no fossil evidence to indicate when, in geologic time, *Pleuronichthys* evolved or entered the north Pacific fauna.

Pleuronichthys

The genus *Pleuronichthys* was described by Girard in 1858, with *coenosus* as the type species. It is closely related to *Hypsopsetta* but differs in numerous

²Since this manuscript went to press, an otolith of *Pleuronichthys* (cf. *ritteri*) was unearthed in the Playa del Rey formation, a Pleistocene deposit (Los Angeles Museum of Invertebrate Paleontology site 59).

characters. Three of the most obvious differences are that *Pleuronichthys* has the dorsal originating on the blind side (median line in *Hypsopsetta*), has either spines or protuberances on the interorbital ridge or around the eyes (head of *Hypsopsetta* is smooth), and has transverse plicae on the thickened lips (no plicae in *Hypsopsetta*).

Within the genus *Pleuronichthys* a number of characters are relatively constant for all members. The scales are cycloid. The lower pharyngeals each have one or two rows of slender, acute teeth. The pelvic fin of the blind side is inserted a little anterior to and farther from the median line than that of the ocular side. The lateral line tubules are not greatly branched. There are 34 to 41 vertebrae, 12 to 15 precaudal plus 22 to 26 caudal. Dorsal rays number 62 to 83; anal rays, 43 to 62; pectoral rays 9 to 14; and caudal rays $10 + 9$ or 19 ($10 + 10$ in one of 58 *coenosus*). The gill rakers are short and weak, ranging from 8 to 17 in number. The head is of about average length, making up between 22 and 27 percent of standard length. Either partially- or fully-ambicolorated individuals have been noted among all species except *ocellatus*. Ambicoloration is rare except in *decurrens*, in which 21 of 899 specimens showed the character to some degree.

There are six species of *Pleuronichthys* in the north Pacific, five American and one Asiatic.

Variation

In *Pleuronichthys*, there is so little interspecific variation (Tables 1 to 4) that meristic characters and proportional measurements seldom will serve to distinguish a particular species from more than one of the remaining five. Once the left eye has migrated to the right side of the fish, and a demersal existence is commenced, no body proportion changes significantly (Table 4). Meristic characters show considerable uniformity for any given species within its entire geographic range (Tables 1, 2, 3). This apparent lack of variation does not preclude positive specific identification, however.

Within any species, greatest variation concerns color patterns, yet volumes have been written about the color-changing capabilities of flatfishes subjected to different substrate patterns. In all species, there is a tendency for brown or black spots on the ocular side at midbody and along the dorsal and ventral body contours. In *ocellatus* and *verticalis*, the midbody spot may be ocellated in white. The black spots of *ocellatus* and *ritteri* have been used as diagnostic characters by numerous workers, yet they frequently are entirely lacking. Similarly, the typically profuse reddish-brown spots of *cornutus* may be large, small, or missing. In the Gulf of California, *verticalis* is brightly mottled and marked in various shades of brown. Such colorful specimens are the exception in *verticalis* from the outer coast, but in each large catch of them, a few specimens display coloration typical of those in the Gulf.

The lateral line has a long, posteriorly extending supratemporal branch in all species. This "accessory lateral line" seldom terminates at the base of the same dorsal ray on both the blind and ocular side. In *coenosus*, *ritteri*, and

ocellatus, a short anterior extension always branches off near its origin. This anterior extension sometimes contains only three or four scales but usually it has more than 15. The other three species are supposed to lack an anterior accessory lateral line; however, such a branch occurs as often as 10 percent of the time in *verticalis* and *decurrens*, and it was noted in 50 percent of the *cornutus* I examined.

Some sexual differences have been noted. The pelvic fins of the males often extend past the anal opening, while those of the females seldom reach the anus. Females grow at a slightly more rapid rate than do males and attain greater maximum lengths, thus most large turbot are females.

When checking meristic characters, 50 individuals apparently will include nearly all extremes. This is amply illustrated by dorsal ray counts for *coenosus*. On 50 specimens, I tallied 66 to 77 dorsal rays; Townsend (1936) counted 65 to 78 in 62 *coenosus* from Washington, near the northern end of their range. The literature failed to reveal any other dorsal ray counts for *coenosus* that were lower than 66 or higher than 75, regardless of where, within the species' range, (Baja California to Alaska) they were taken. A similar situation was encountered with *decurrens*.

The fewest dorsal rays noted for any species of *Pleuronichthys* was 62 (*ritteri* and *ocellatus*), while the most was 83 (*cornutus*), a total spread of only 22 rays (Table 1). Four of the six species have dorsal ray counts that range over 13 or 14 numbers of the 22-ray spread noted for the genus (*ocellatus* have 62 to 74, *verticalis* have 66 to 79, *decurrens* have 67 to 79, and *cornutus* have 70 to 83). Dorsal ray counts for the other two species range through 9 to 12 numbers.

Relationships

Norman (1934) indicates *Pleuronichthys* is closely related to *Hypsopsetta*, and points out numerous characters by which the two genera differ. Most salient of these are the dorsal fin insertion on the blind side in *Pleuronichthys* (in *Hypsopsetta* it originates on the median line of the head), and the high interorbital ridge in *Pleuronichthys*, generally provided with bony spines or protuberances (*Hypsopsetta* has a low interorbital, lacking in spines or prominences).

In *P. verticalis* and *P. cornutus* the interorbital ridge attains its greatest development, terminating both anteriorly and posteriorly in a sharp, projecting spine. Near its anterior end in these two species there is also a spine which rises vertically from the ridge, being higher and sharper in *verticalis*. The ridges of *ritteri*, *ocellatus*, and *coenosus* are about equal in their development. In these three, there are slightly raised, round bony protuberances at the anterior and posterior ends of the ridge, and a small bony lump on the dorsal surface of the ridge near its anterior end. *P. decurrens* is intermediate between the spiny ridged *verticalis*-*cornutus* complex and the *ritteri*-*ocellatus*-*coenosus* group. In addition, *decurrens* often has several raised bony prominences around the posterior margin of the upper orbit.

The dorsal fin also shows variation in its origin on the blind side. In five species (*verticalis*, *cornutus*, *ritteri*, *ocellatus*, and *coenosus*), it originates on about a level with the snout, well above the lower corner of the mouth. In *decurrens*, except for completely ambicolored individuals where it originates on a level with the snout, the dorsal fin originates much lower on the blind side, usually opposite and level with the lower corner of the mouth.

Two other features showing specialization within *Pleuronichthys* are the dentition on the ocular side of the jaw and the development of the supra-temporal branch of the lateral line.

In four species (*decurrens*, *ritteri*, *ocellatus*, and *coenosus*), there is a single row of small, blunt teeth in the lower jaw on the ocular side. This side of the lower jaw of *verticalis* and *cornutus* is without teeth.

Finally, in all species of *Pleuronichthys* there is a supratemporal branch of the lateral line with a well developed posterior prolongation. However, three species (*ritteri*, *ocellatus*, and *coenosus*) also have a short anterior prolongation. In *verticalis* and *decurrens* there rarely is an indication of an anterior prolongation of the supratemporal lateral line branch, while in *cornutus* it was noted on about half of 57 specimens checked.

When all these characters are considered, a pattern of relationship materializes.

Species	Dorsal origin	Interorbital ridge development	Lower jaw teeth ocular side	Anterior accessory lateral line
<i>verticalis</i>	high	strong	absent	absent
<i>cornutus</i>	"	"	"	" (mostly)
<i>decurrens</i>	low	intermed.	present	"
<i>ritteri</i>	high	weak	"	present
<i>ocellatus</i>	"	"	"	"
<i>coenosus</i>	"	"	"	"

Thus, *verticalis* and *cornutus* form a specialization complex at one level, while *ritteri*, *ocellatus*, and *coenosus* group naturally at the other extreme (Fig. 1). Because of the stronger interorbital ridge spine development in *verticalis*, I believe it earns the distinction of being the most highly specialized of the *Pleuronichthys*, while *coenosus* with the lowest and flattest interorbital ridge is the least specialized. *P. decurrens*, because of its intermediate ridge development and lower dorsal fin origin, is placed between the two complexes mentioned above. The lines in Figure 1 are meant to show relationship because of common characters, they should not be construed as depicting evolution of the various species in time.

SPECIES IDENTIFICATION

Only two previous works have covered all species of *Pleuronichthys* (Starks and Thompson, 1910; Norman, 1934); however, neither of these provided sufficient information to make it possible to identify all material at hand.

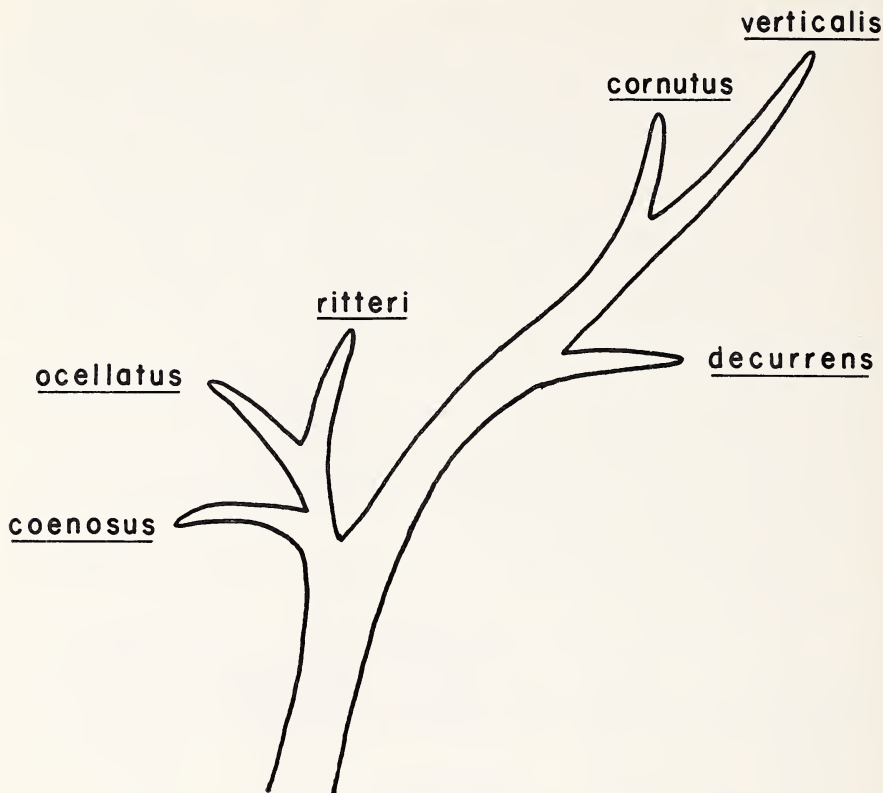


Figure 1. Probable relationships of the species of *Pleuronichthys*.

Starks and Thompson described *P. nephelus* as new, and Norman accepted this species. It is here shown to be conspecific with *P. coenosus*. Former reviewers relied heavily upon lateral line scale counts, yet lateral line scales are the most difficult of all the meristic characters to distinguish because they are deeply covered by integument and masked by innumerable small accessory scales. To obtain an accurate pored scale count, it is almost necessary to remove all other scales above and below the lateral line—a meticulous and time-consuming task that can be accomplished only on fresh material with the aid of a dissecting scope.

Gill raker and fin ray counts have been relied upon in the past as key characters when they actually are not definitive for any given species. I found overlapping counts for five of the six species at six different numbers (27 percent of the total range, Table 1) for dorsal fin rays, and at four different numbers (20 percent of the total range, Table 1) for anal fin rays. Similarly, four of the six species have overlapping gill raker counts for 30 percent of their range (Table 3).

Finally the black spots often used to key out *ritteri* and *ocellatus* are not always present; however, in their absence, other characters as used in the following key are perfectly valid.

Key to Species of *Pleuronichthys*

1. No teeth on ocular side of jaws; interorbital ridge terminating posteriorly in a sharp backward projecting spine **2**
A single row of minute jaw teeth on ocular side of mandible; interorbital ridge never terminating posteriorly with a sharp, backward projecting spine (occasionally a slightly raised bony tubercle may be present) **3**
2. Ocular side of body and fins plain colored, mottled, or marbled, never covered with small brown spots; several white flecks or spots along dorsal and ventral body margins; anal fin rays 44-51; snout to anal fin insertion 34.9 to 39.3 percent of standard length *verticalis* (p. 15)
Ocular side of body and fins uniformly covered with small brown spots; never with white streaks or spots along dorsal and ventral body margins; anal fin rays 52 to 62; snout to anal fin insertion 29.8 to 33.8 percent of standard length *cornutus* (p. 18)
3. Origin of dorsal fin opposite (level with) lower corner of mouth on blind side; supratemporal branch of lateral line with a posterior prolongation only (2 of 50 specimens had short anterior branches also); precaudal vertebrae 14 or 15 *decurrens* (p. 20)
Origin of dorsal fin well above lower corner of mouth on blind side, usually about on level of snout; supratemporal branch of lateral line always with anterior as well as posterior prolongations; precaudal vertebrae 12 or 13 **4**
4. Caudal peduncle narrow, 4.4 to 5.6 into body height; bony orbit of upper eye relatively small, 6.3 to 8.1 percent of standard length, 6.6 to 8.8 times into body height; ocular side of body usually with a solid black blotch (no white border) on the fish's mid-line at ½ its standard length *ritteri* (p. 23)
Caudal peduncle wider, 3.8 to 4.4 into body height; bony orbit of upper eye larger, 8.1 to 10.9 percent of standard length, 4.7 to 6.4 times into body height; if a black blotch is present on center of ocular side of body (*ocellatus*), it is encircled with white **5**
5. Ocular side of body almost always with a large black blotch bordered with white on fish's mid-line at ½ its standard length; total vertebrae 34 or 35 *ocellatus* (p. 26)
Ocular side of body plain, without distinguishing black blotches or spots; total vertebrae 37 to 39 *coenosus* (p. 28)

Field Recognition

The six species of *Pleuronichthys* can be determined at a glance if one is thoroughly familiar with all of them. In freshly caught specimens, color and "texture" differences are sufficient to distinguish the various species, but these differences are usually relative.

P. decurrens and *ritteri* have basically dark green shades on their ocular sides, generally distinguishing them from the other four species, which have brown tones predominating. The distinct "pebbly" appearance of *decurrens*, caused by slightly depressed scales, separates it from *ritteri*, and the other species. In addition, the numerous high, bony protuberances along the interorbital ridge and posterior rim of the orbit (much more rugose and numerous than any other species), and the dorsal origin opposite the lower corner of the mouth on the blind side, will rule out all other turbot.

The other basically "green colored" turbot, *ritteri*, lacks the characters mentioned above for *decurrens*. The black blotch on *ritteri*'s mid-body and two others just inside the dorsal and ventral body contours about a head length anterior to the last fin rays, when they are present (perhaps 50 percent of the time), will furnish positive identifying characters. If these black blotches are not present, or even if they are, the diamond-shaped body, narrow caudal peduncle, and thinness of the fish, while relative characters, are excellent for substantiating identity.

The scales of all *Pleuronichthys* are covered by integument, but some more-so than others. One of the "smoothest" turbot is *verticalis*, and its smoothness plus its yellowish-brown body flecked with irregular white spots along the dorsal and ventral contours are sufficient to distinguish it. Other easily observed characters are the overhanging sharp spine on the posterior end of the interorbital ridge (sometimes broken or damaged), and the lack of jaw teeth on the ocular side.

The basic body color of *coenosus* (brownish-green) coupled with its "highlighted" scalation (the body scales on its ocular side are more heavily outlined by pigment than are the scales on other turbot), and the typical (if present) caudal pattern (a dusky C-shaped ring partially surrounding a dark circular blotch), will positively identify this species. Other helpful characters include numerous dusky blotches on an otherwise white blind side in most adults, a generally oval body outline, a relatively broad, flat caudal peduncle, and a relatively smooth, low, bony interorbital ridge.

The gulf turbot, *ocellatus*, typically is uniformly light brown, and almost all specimens have a large circular black spot bordered with white at midbody on the ocular side. These two characters will usually distinguish *ocellatus* at a glance; however, it is also helpful to know that *ocellatus* has a relatively wide caudal peduncle, slight bony protuberances on the interorbital ridge, and black spots on the body contours about where they are found on *ritteri*. *P. ocellatus* and *verticalis* are the only two *Pleuronichthys* in the Gulf of California.

The only other turbot, *cornutus*, is the easiest of all to distinguish if it has its typical pattern of brownish spots evenly covering the entire ocular side of the body and fins. In some, the spots are minute, and in others they appear to be mostly lacking; however, additional support toward positive identification may be obtained from the overhanging sharp spine on the posterior end of the interorbital ridge and the lack of jaw teeth on the ocular side. Finally, this is the only member of the genus inhabiting waters on the Asiatic side of the Pacific.

Hornyhead turbot, *Pleuronichthys verticalis* Jordan and Gilbert, 1881

Differential Diagnosis: May be distinguished from all other species of *Pleuronichthys*, except *cornutus*, by the lack of jaw teeth on the ocular side and by the sharp, backward-projecting spine on the posterior end of the interorbital ridge. It can be distinguished from *cornutus* by its plain-colored body and fins (*cornutus* is uniformly covered with brown spots), by its lower anal fin ray count (44 to 51 compared with 52 to 62 for *cornutus*), by its greater distance between snout and anal fin insertion (34.9 to 39.3 percent of standard length compared with 29.8 to 33.8 percent for *cornutus*), and by its extremely fleshy lips.

Additional Distinguishing Characters: Dorsal rays 66 to 75; anal rays 44 to 51; pectoral rays 10 to 12; total gill rakers 9 to 11; pored lateral line scales 88 to 103; total vertebrae 36 to 38, precaudal vertebrae 13, caudal vertebrae 23 to 25; anterior branch of accessory dorsal lateral line absent on 88 percent of specimens; posterior branch of accessory lateral line reaches base of dorsal ray 29 to 48 on ocular side, lips more fleshy than for any other member of the genus.

Color: When fresh, body on ocular side is yellowish-brown with whitish flecks and spots along dorsal and ventral contours. Various intensities of the general body color give an overall appearance of marbling, particularly among Gulf of California specimens which are especially brightly marbled. Many specimens have a brownish-white rosette-like blotch at midbody on the ocular side. Almost all have small, irregular, white "streaks" along their dorsal and ventral contours.

Distribution: Pt. Reyes, California, south to Magdalena Bay, Baja California, and in the northern Gulf of California.

Spawning: Females were encountered every month of the year with enlarged (ripe) gonads containing transparent eggs. During April, May, and June many males were encountered from which milt would run when pressure was applied over the gonads. Budd (1940) was unable to obtain fertilized eggs of *verticalis* in plankton tows at Monterey until late April but they were found from then until late August. None was taken during late fall and winter, however.

Eggs: According to Budd (1940) the pelagic eggs are spherical with a diameter of 1.07 (1.03-1.11) mm. The thin membrane appears slightly trans-

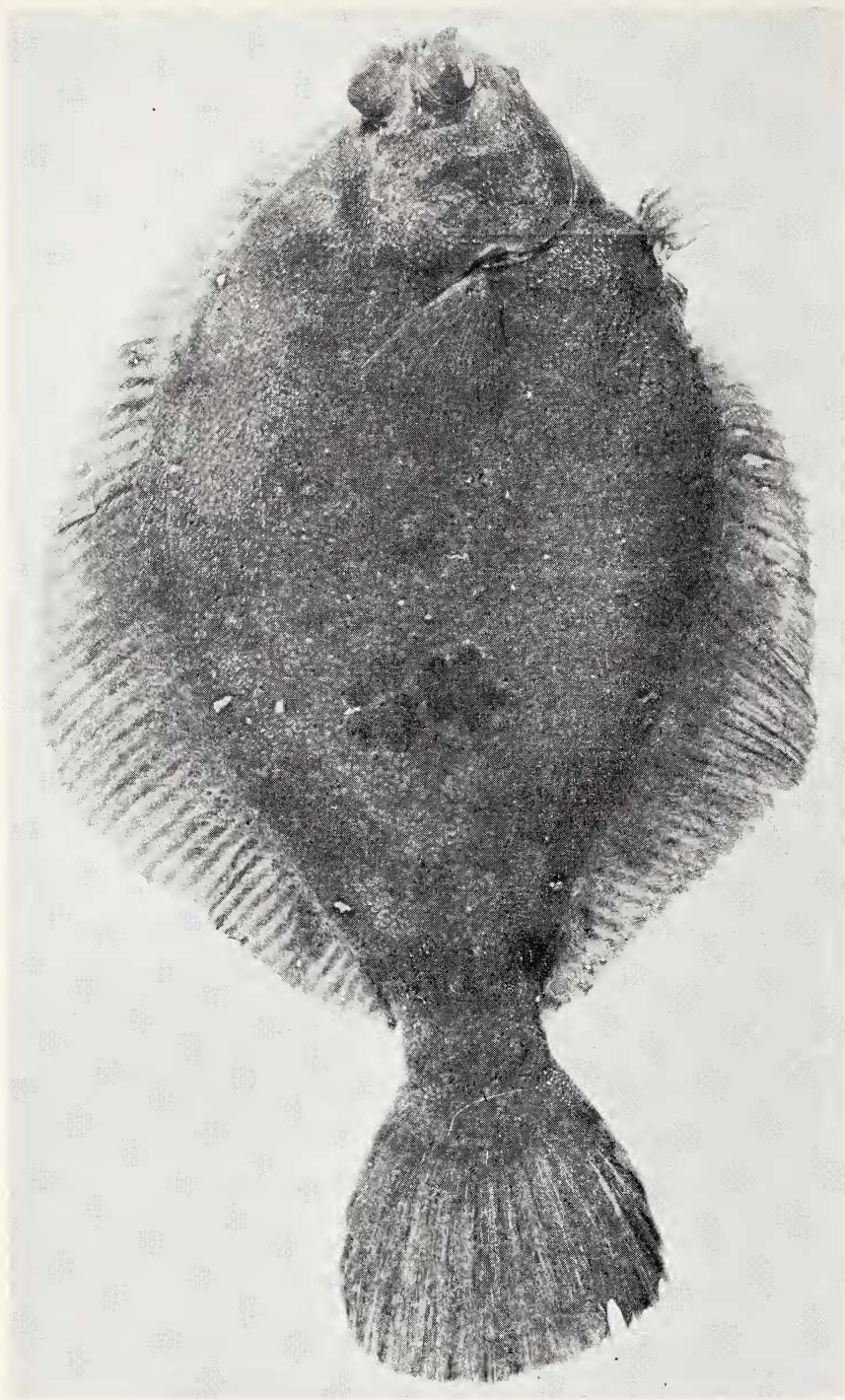


Figure 2. Hornyhead turbot, *Pleuronichthys verticalis*, 203 mm.s.l., 256 mm.t.l., collected at Cape Colnett, Baja California, January 9, 1959. Photograph by Jack W. Schott.

lucent because of a hexagonal pattern extending through the entire thickness of it. The yolk is perfectly clear and transparent. Hatching was estimated to occur about 4 days after fertilization.

Larvae: Newly hatched larvae measure about 3.16 mm. in standard length and are hampered in their movements by a buoyant yolk sac (Budd, 1940). There is no indication of a mouth and the yolk sac extends to the rectum, about the mid-point of the body. The body is well covered with amber chromatophores and sparsely sprinkled with melanophores. By six days the larva measures about 3.35 mm. and has well-formed, functional jaws. Budd did not carry *verticalis* larvae past six days.

Maximum Size: The largest encountered (of 3,774) was 295 mm. standard length (365 mm. total) and weighed 835 grams. It was a ripe female trawled in 6½ fathoms off Oceanside on April 22, 1957. No larger specimen appears to be noted in the literature.

Food: Of 12 stomachs examined, three were empty, two contained clam siphons alone, two contained polychaet worms alone, and five contained a preponderance of clam parts (mostly siphons) and small amounts of polychaet worms.

Depth Distribution: Specimens were trawled at all depths from 5 to 102 fathoms, but most were taken between 25 and 50 fathoms.

Sex Ratios: Of 2,590 individuals sexed, 530 (20 percent) were males. At the height of spawning in the late spring nearly equal number of males and females are captured in trawling operations. At other times the catch is predominantly females; usually the largest individuals are exclusively females.

Material Examined: In all, I examined and identified 3,774 specimens of *verticalis*: 3,139 were from Californian waters; 621 were from the outer coast of Baja California; and 14 were from the upper Gulf of California.

Synonymy:

Pleuronichthys verticalis: Jordan and Gilbert, Proc., U.S. Natl. Mus., 3, 1880: 49-50 (type descr., outside Golden Gate); Jordan and Gilbert, Proc. U.S. Natl. Mus., 4, 1881:68-69 (ecol., size, food, life hist., Monterey, San Francisco); Jordan and Jouy, Proc. U.S. Natl. Mus., 4, 1881:1 (Mont., S. F.); Jordan and Evermann, Bull. U.S. Natl. Mus., 47(3) 1898:2604, 2637-2638 (anat., color, tax., syn., distrib.); Starks and Morris, Univ. of Calif. Publ. Zool., 3, 1907:243-244 (tax., S. Francisco to S. Diego); Gilbert, Proc. U.S. Natl. Mus., 48, 1915:378 (localities); Hubbs, Univ. Calif. Publ. Zool., 16, 1916:168 (size, color, S. Fran.); Starks, Calif. Fish and Game, 4, 1918:171 (tax., anat., color, distrib., fig.); Higgins, Calif. Fish and Game, 5, 1919:157 (records); Fowler, Proc. Acad. Nat. Sci. Phila., 75, 1923:297 (So. Calif. localities); Fowler, Copeia 120, 1923:79 (Long Beach aquarium); Ulrey and Greeley, Bull. So. Calif. Acad. Sci., 28(1) 1928:32 (So. Calif. coast); Ulrey, J. Pan-Pac. Res. Inst., 4(4) 1929:5 (So. Calif.); Jordan, Evermann, and Clark, Rep. U.S. Comm. Fish., 1930:225 (Calif. coast); Walford, Calif. Div. Fish and Game, Fish Bull. 28, 1931:154 (common name, tax., anat., color, size, distrib., fig.); Croker, Calif. Div. Fish and Game, Fish Bull. 40, 1933:90 (with netted mackerel); Norman, Monograph of flatfishes, 1, 1934:317, 321-322 (tax., syn., anat., color, size, distrib., fig.); Phillips, Calif. Fish and Game, 21, 1935:142-143 (netted Monterey); Barnhart, Marine fishes So. Calif., 1936:28-29 (tax., anat., color, size, distrib., fig.);

Kumada and Hiyama, Marine fishes Pac. Coast Mex., 1937:50 (diagnosis, misprinted "*verticularis*," fig.); McCully, Calif. Fish and Game, 35(1) 1939:13 (field key); Roedel, Calif. Div. Fish and Game, Fish Bull. 68, 1948: 12, 24, 138 (common name, characters, relationship, use, gear, distrib., fig.); Clothier, Calif. Div. Fish and Game, Fish Bull. 79, 1950:44-45 (vert. characters, Newport Beach to Gaviota); Cannon, How to Fish Pac. Coast, 1953:226-227 (names, descript., color, size, range, fishing methods, fig.); Roedel, Calif. Dept. Fish and Game, Fish Bull. 91, 1953:69 (common name, range, descr., use, size, color, fig.); Berdegue, Sect. Mar. Mex., 1956:315 (fig., tax., descr., color, distrib., use); Miller, Calif. Dept. Fish and Game, Field Guide 1, 1959:26-27 (characters, illus. key, distrib.).

Asiatic turbot, *Pleuronichthys cornutus* (Temminck and Schlegel, 1846)

Differential Diagnosis: May be distinguished from all other species of *Pleuronichthys* except *verticalis* by the lack of jaw teeth on the ocular side and by the sharp, backward-projecting spine on the posterior end of the inter-orbital ridge. It can be distinguished from *verticalis* by its uniformly brown-spotted body and fins on the ocular side (*verticalis* has no such brown spots), by its higher anal fin ray count (52 to 62 compared with 44 to 51 for *verticalis*), and by its shorter distance between snout and anal fin insertion (29.8 to 33.8 percent of standard length compared with 34.9 to 39.3 percent for *verticalis*).

Additional Distinguishing Characters: Dorsal rays 70 to 83; anal rays 52 to 62; pectoral rays 10 to 12; total gill rakers 8 to 10; pored lateral line scales 92 to 105 (98 to 110 by Norman, 1934; 93 to 118 by Okada, 1955); total vertebrae 36 to 38, precaudal vertebrae 12 or 13, caudal vertebrae 23 to 25; anterior branch of accessory lateral line present on nearly 50 percent of the specimens; posterior branch of accessory lateral line reaching base of dorsal ray 38 to 53 on ocular side.

Color: When fresh, greyish-brown to reddish-brown on ocular side, covered with brownish spots which may be from pinhead to eye-diameter size. Smaller spots profusely sprinkled over dorsal and anal fins.

Distribution: Coasts of China, Japan, Korea, and Formosa.

Spawning: Fall and winter according to Okada (1955).

Maximum Size: Fowler (1933) gives 305 mm. total length.

Food: Small worms and crustaceans (Okada, 1955).

Depth Distribution: Trawled to depths of 125 fathoms (Jordan and Starks, 1904).

Material Examined: I examined 57 specimens of *cornutus*, 6 from the Stanford University collection and 51 from the University of Michigan collection. These had been taken from off China, Japan, and Korea.

Synonymy:

Platessa cornuta: Temminck and Schlegel, Faun. Jap., Poiss., 1846: 179 (type descr., fig., Nagasaki); Bleeker, Verh. Batav. Gen. 26, 1854:121 (Japan); Boeseman, Zool. Meded., 28, 1947:145-146 (color, localities, characters, tax., Spec. 1336 designated as Temminck and Schlegel's type).

Heteroprosopon cornutus: Bleeker, Compt. Rend. Ac. Sci. Amst., 1862; 8 (Nagasaki).

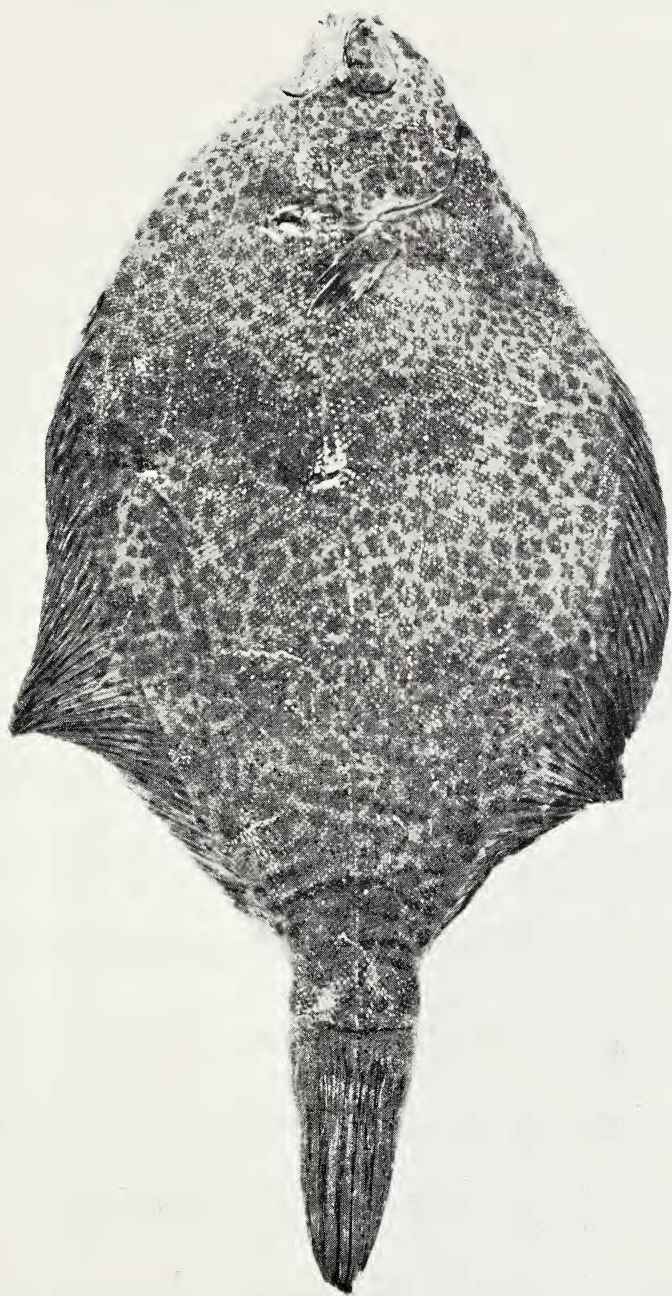


Figure 3. Asiatic turbot, *Pleuronichthys cornuttus*, 108 mm.s.l. 138 mm.t.l., collected at Hong Kong, China, November 10, 1936 (SU 32779). Photograph by Jack W. Schott.

Parophrys cornuta: Günther, Cat. Fish, 4, 1862:455 (listed, copied); Günther, Shore fishes, Challenger, 1880:70 (Kobel); Namiye, Class. Cat., 1881:110 (Tokyo); Ishikawa and Matsuura, Prel. Cat., 1897:24 (Yeshigo); Otaki, J. Bur. Fish., 1897:7, 90 (fig., Japan).

Pleuronichthys cornutus: Steindachner, Reise Aurora, 1896:217 (Kobe); Jordan and Evermann, Bull. U.S. Natl. Mus., 47(3), 1898:2637 (key, Japan); Jordan and Snyder, Proc. U.S. Natl. Mus., 23, 1901:769, (listed, common Japan); Jordan and Starks, Bull. U.S. Fish Comm., 22, 1902 (1904):623 (Suruga Bay 65-125 fms.); Jordan and Starks, Proc. U.S. Natl. Mus., 31 (1484) 1907:200-202 (tax., syn., vernacular names, habitat, characters, color, distrib.); Starks and Thompson, Proc. U.S. Natl. Mus., 38 (1744) 1910:277-287 (tax., rel., characters, key, distrib.); Jordan and Metz, Mem. Carnegie Mus., 6(2) 1913:60 (listed, Fusan); Jordan, Tanaka, and Snyder, J. Coll. Sci., Tokyo, 33(1) 1913:325 (listed, distrib.); Jordan and Thompson, Mem. Carnegie Mus. 6(4), 1914:309 (listed, Misaki); Hubbs, Proc. U.S. Natl. Mus., 48 (2082) 1915:475-476 (syn., characters, variation, measurements, localities); Jordan and Hubbs, Mem. Carnegie Mus., 10, 1925:298 (common name, records, characters); Oshima, Jap. J. Zool., Trans. Abstr., 1(5) 1927:194; Mori, J. Pan-Pac. Res. Inst., 3(3) 1928: 3-8 (Korea); Schmidt, Bull. Acad. Sci. U.S.S.R., 1931:119 (listed); Schmidt, Transl. Pac. Comm. Acad. Sci. U.S.S.R., 2, 1931:126 (size, Nagasaki); Norman, Monograph of flatfishes, 1, 1934:318-321 (tax., syn., key, descr., color, distrib.); Fowler, Hong Kong Nat., 4(2) 1933:169-170 (tax., syn., characters, color, size, distr.); Okada, Fishes of Japan, 1955:384-385 (vernacular names, descr., color, size, habits, distrib., spawning, food, "figure is misprinted sinistral").

Curlfin turbot, *Pleuronichthys decurrens* Jordan and Gilbert, 1881

Differential Diagnosis: May be distinguished from all other species of *Pleuronichthys* by its dorsal fin origin being opposite (level with) lower corner of mouth on blind side (for all other species the dorsal originates on blind side well above lower corner of mouth, usually on a level with snout) and its higher precaudal vertebral count (14 to 15 in *decurrens*, 12 to 13 for all others).

Additional Distinguishing Characters: Dorsal rays 67 to 79; anal rays 45 to 53; pectoral rays 10 to 14; total gill rakers 9 to 12; pored lateral line scales 82 to 96; total vertebrae 38 to 41, precaudal vertebrae 14 to 15, caudal vertebrae 24 to 26; anterior branch of accessory lateral line absent in 96 percent of specimens; posterior branch of accessory lateral line reaches base of dorsal ray 38 to 56 on ocular side; single row of minute teeth in mandible on ocular side; two or three bony protuberances along posterior bony rim of upper eye; skin on ocular side "pebbly" in appearance because of slightly depressed scales; numerous fine brown spots over dorsal and anal rays and membranes on ocular side.

Color: When fresh, deep olive-green on ocular side of body and fins. Dorsal and anal fins uniformly speckled with brownish spots. Specimens frequently seen with blind side either completely brown except for head (ambicolored) or half-brown.

Distribution: Alaska south to San Quintin, Baja California.

Spawning: Transparent eggs have been noted in their ovaries from Novem-

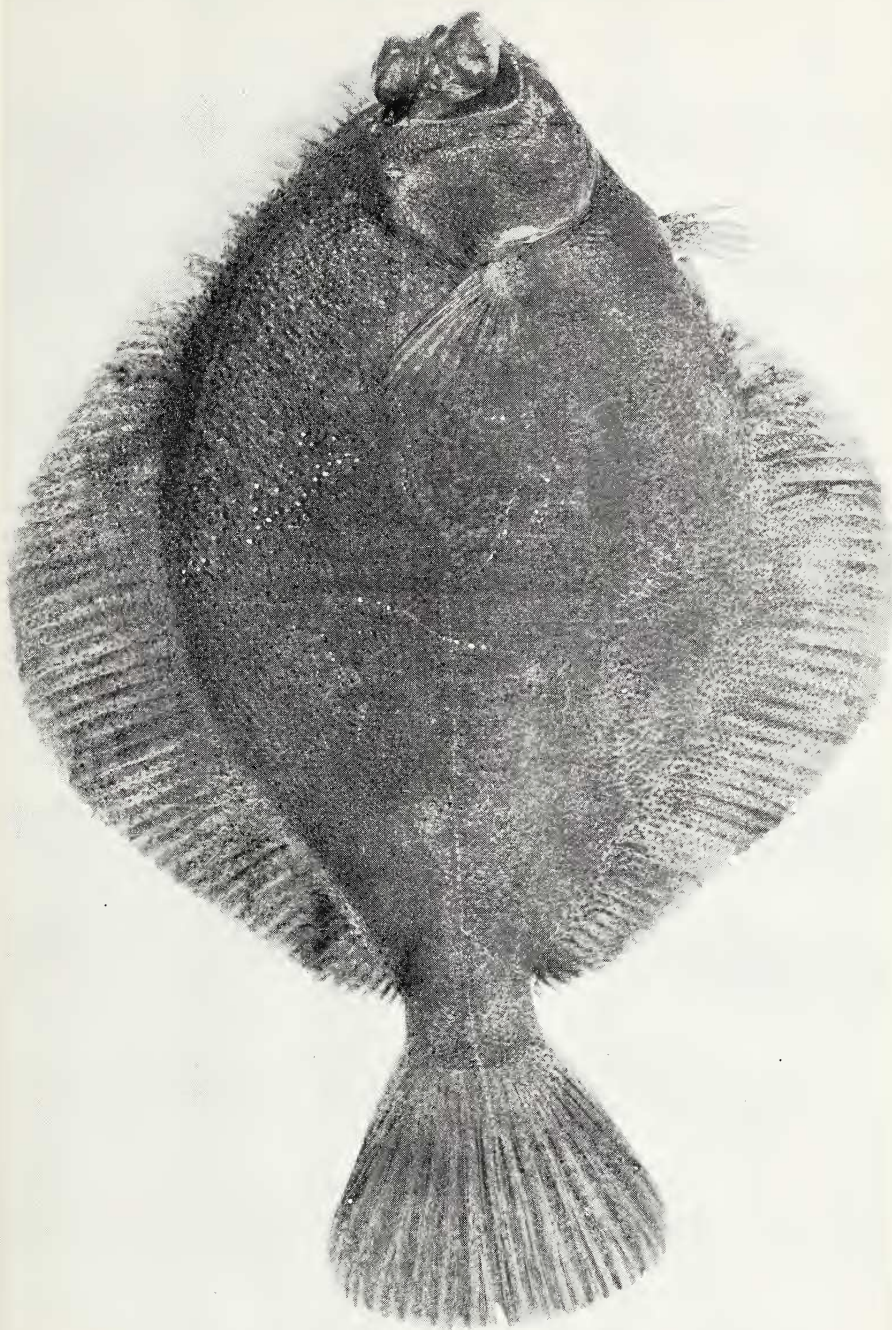


Figure 4. Curlfin turbot, *Pleuronichthys decurrens*, 171 mm.s.l., 222 mm.t.l. collected off Seal Beach, California, November 13, 1956. Photograph by Jack W. Schott.

ber through June; however, according to Budd (1940) their spawning season corresponds closely to that of *verticalis*, roughly late April through August.

Eggs: The pelagic eggs have a specific gravity about equal to that of sea water, are spherical, and average 1.44 (1.31-1.50) mm. in diameter, being considerably larger than *verticalis* eggs. Each egg is enclosed in a thin membrane which appears slightly translucent because of a hexagonal pattern throughout its thickness. The yolk is clear and transparent and contains no oil globule (Budd, 1940). Hatching was estimated to occur in slightly less than 7 days (160 hours) after fertilization.

Larvae: Newly hatched larvae measure about 3.88 mm. in standard length. They may be distinguished from larvae of *verticalis* by a more evenly rounded head and by the fact the dorsal fin fold never displays a sharp supra-cephalic crest. The general body melanophores are more numerous than in *verticalis* but the rectum is less heavily pigmented. Four days after hatching the larva measures 4.35 mm. in standard length and the jaws are functional (Budd, 1940). Budd was unable to carry larvae of *decurrens* past 11 days; they were slightly longer than 4.75 mm. standard length at that time.

Maximum Size: The largest encountered (of 899 measured) was 363 mm. total length, weighing 774 grams. It was a female trawled off Santa Rosa Island on June 13, 1961, in 70 to 80 fathoms. No record could be found in the literature of any that were larger.

Food: Twelve stomachs were examined and two of these were empty. Of the remainder, six contained polychaet worms, three contained nudibranchs or tectibranchs, and one was filled with crustacean (crab?) eggs and brittle star fragments.

Depth Distribution: Seldom trawled in depths shallower than 10 fathoms. Gilbert (1895) states *decurrens* was taken at depths of 21 to 191 fathoms (misquoted by Clemens and Wilby, 1962, as 21 to 291 fms.); none seems to have been taken below 102 fathoms south of Pt. Conception, however.

Sex Ratio: Of 693 individuals sexed, 170 (24 percent) were males. This ratio did not seem to differ greatly during the height of the spawning season. The largest individuals are exclusively females.

Material Examined: In all, 899 specimens of *decurrens* were examined and identified. One of these was from off Coos Bay, Oregon; 882 were from Californian waters; and 16 were from off Baja California as far south as San Quintin.

Synonymy:

Pleuronichthys decurrens: Jordan and Gilbert, Proc. U.S. Natl. Mus., 4, 1881: 68-69 (type descr., ecol., food, size, life hist., Monterey and San Francisco north); Jordan and Jouy, Proc. U.S. Natl. Mus., 4, 1881:2 (Monterey and San Francisco); Gilbert, Rept. U.S. Comm. Fish., 19, 1895:473 (*Albatross* collections 21 to 191 fms.); Jordan and Evermann, Bull. U.S. Natl. Mus., 47(3) 1898:2637-2638 (anat., tax., color, size, syn., Monterey north mostly deep water); Garman, Mem. Mus. Comp. Zool. Harvard, 24, 1899:398 (off Calif. coast); Jordan and Evermann, Bull. U.S. Natl. Mus., 47(4) 1900:3310 (San Francisco, fig. 926); Starks and Morris,

Univ. Calif. Publ. Zool., 3, 1907:244 (tax., S. Barb. Isls. to S. Francisco); Starks and Thompson, Proc. U.S. Natl. Mus., 38(1744) 1910:277-279 (tax., anat., color, size, San Pedro to S. Francisco); Snyder, Proc. U.S. Natl. Mus., 44, 1913:458-459 (size, color, young at 10-15 fms., Mont. Bay); Gilbert, Proc. U.S. Natl. Mus., 48, 1915:378 (S. Nicolas Isl. 31-32 fm.); Starks, Calif. Fish and Game, 4, 1918:164, 170 (tax., anat., not uncommon in deep water); Higgins, Calif. Fish and Game, 6, 1920:87-88 (Huntington Beach); Ulrey and Greeley, Bull. So. Calif. Acad. Sci., 28(1) 1928:32 (S. F. to S. Barb. Isls.); Ulrey, J. Pan-Pac. Res. Inst., 4(4) 1929:5 (So. Calif.); Jordan, Evermann, and Clark, Rept. U.S. Comm. Fish., 1930:225 (Mont. north); Walford, Calif. Div. Fish and Game, Fish Bull. 28, 1931:3, 18, 153 (common name, tax., anat., color, size, range, fig.); Schultz, Hart, and Gunderson, Copeia, 1932(2):67-68 (Zaikof Bay and Wrangell, Alaska); Norman, Monograph of flatfishes, 1, 1934:317-319 (tax., syn., anat., color, size, distrib., fig.); Phillips, Calif. Fish and Game, 21, 1935:142-143, 148 (netted Mont. Bay); Barnhart, Marine fishes of So. Calif., 1936:28-30 (tax., anat., color, size, distrib., fig.); Schultz, Univ. Wash. Publ. Biol., 2(4) 1936:158 (tax., distrib.); Schultz and DeLacy, Mid-Pac. Mag., 49(1) 1936:67 (syn., refs., Alaska to S. Barb. Isls.); Townsend, Rept. Int. Fish. Comm., 11, 1936:8-10 (vert. characters); Budd, Calif. Div. Fish and Game, Fish Bull. 56, 1940:27-32 (spawning, eggs and larvae figured, Monterey); Clemens and Wilby, Bull. Fish. Res. Bd. Canada, 68, 1946:319-320 (name, characters, size, records, range, fig.); Roedel, Calif. Div. Fish and Game, Fish Bull. 68, 1948:12, 24, 139 (common name, characters, use, fishery, distrib., fig.); McCully, Calif. Fish and Game, 35(1) 1949:13 (field key); Clothier, Calif. Div. Fish and Game, Fish Bull. 79, 1950:25-27, 45 (vert. characters, Eureka, Crescent City); Cannon, How to Fish Pac. Coast, 1953:226-227 (names, characters, size, color, range, fishing tackle, fig.); Roedel, Calif. Dept. Fish and Game, Fish Bull. 91, 1953:68 (common name, distrib., characters, fig.); Wilimovsky, Stan. Ich. Bull., 4(5) 1954:283 (listed, southeast Alaska); Best, Calif. Fish and Game, 45(1) 1959:5-18 (fishery); Miller, Calif. Dept. Fish and Game, Field Guide 1, 1959:26-27 (characters, distrib., illust. key); Clemens and Wilby, Bull. Fish. Res. Bd. Canada, (second edit.), 68, 1961:191-192 (common name, tax., characters, size, Brit. Col. records, distrib.).

Paralichthys californicus: Herz, [not *P. californicus* of Ayres] Sci. Guide Element. Schools, 6(3) 1941:37-38 (field characters, size, distrib., fig.).

Pleuronichthys coenosus: Lockington, Proc. U.S. Natl. Mus. 2, 1879: 72, 97-100 (key; in part, excluding specimen "4"; descr., meas., counts, possibly identical with *Pleuronectes quadrituberculatus* Pallas, if so, to be called *Pleuronichthys quadrituberculatus*); Jordan and Gilbert, Proc. U.S. Natl. Mus., 3, 1880:50 (in part, includes *Pleuronichthys coenosus* Lockington, except his spec. 4; probably identical with *Pleuronectes quadrituberculatus* Pallas).

Pleuronectes quadrituberculatus: Lockington, Proc. U.S. Natl. Mus., 2, 1879:99 (*Pleuronichthys coenosus* possibly a synonym); Jordan and Gilbert, Proc. U.S. Natl. Mus., 3, 1880:50 (synonym of *Pleuronichthys quadrituberculatus*).

Pleuronichthys quadrituberculatus: Lockington, Proc. U.S. Natl. Mus., 2, 1879: 99 (*Pleuronichthys coenosus* possibly a synonym); Jordan and Gilbert, Proc. U.S. Natl. Mus., 3, 1880:50 (*Pleuronichthys coenosus* Lockington a synonym, in part; *Pleuronectes quadrituberculatus* Pallas a synonym; characters, measurements, localities of capture).

Spotted turbot, *Pleuronichthys ritteri* Starks and Morris, 1907

Differential Diagnosis: May be distinguished from all other species of *Pleuronichthys* except *ocellatus* and *verticalis* by its low vertebral count (34 to 36 total vertebrae for *ritteri*, 37 to 41 for all others except *ocellatus* and

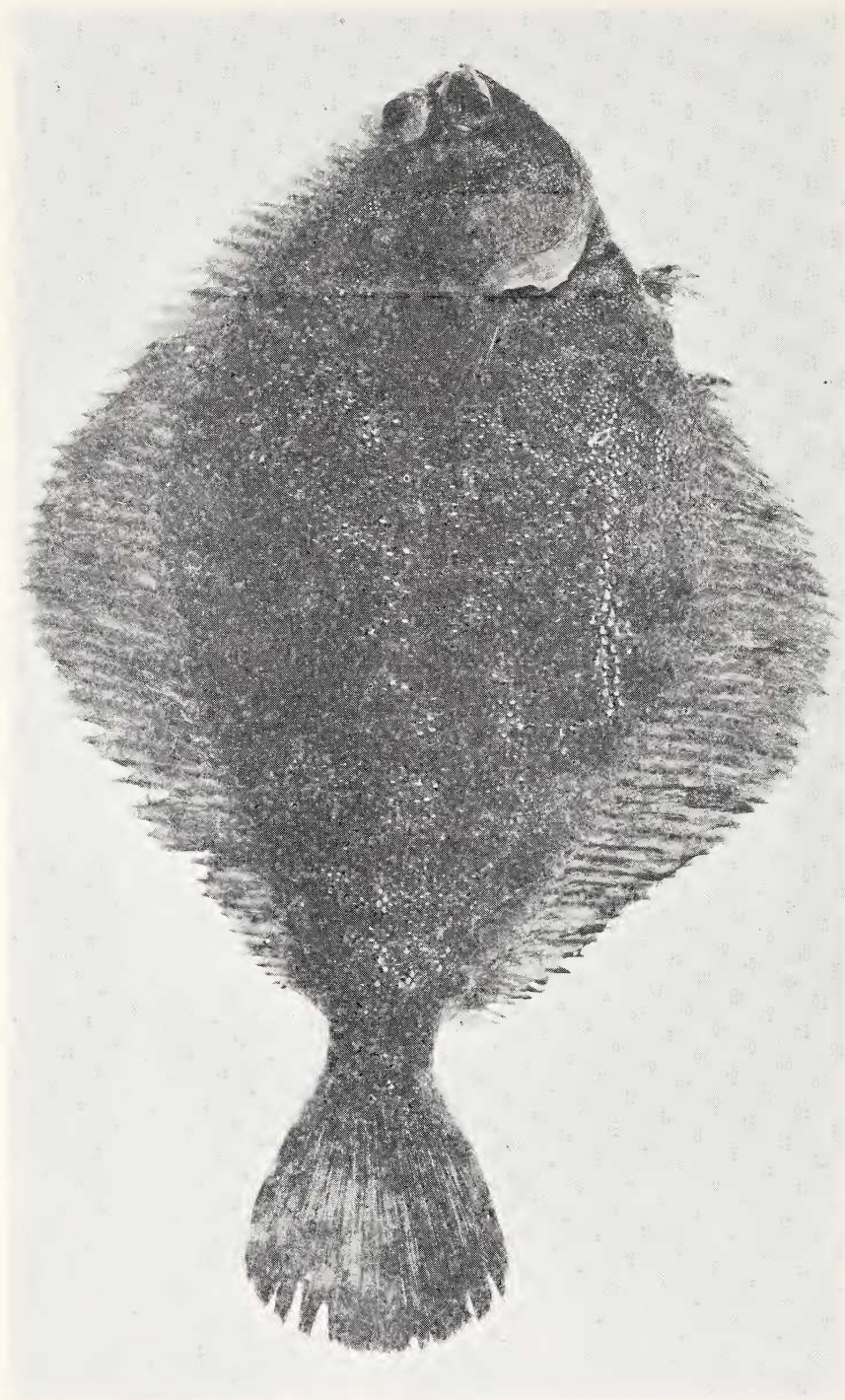


Figure 5. Spotted turbot, *Pleuronichthys ritteri*, 226 mm.s.l., 284 mm.t.l., collected at Belmont Shore, California, November 7, 1956. Photograph by Jack W. Schott.

verticalis). Differs from *verticalis* by having a single row of minute teeth in ocular side of lower jaw (*verticalis* has none), and from *ocellatus* by having a smaller bony upper orbit (6.3 to 8.1 percent of standard length compared with 8.5 to 10.9 percent for *ocellatus*), by having a shorter interorbital ridge measured from the first to third protuberance (5.8 to 7.7 percent of standard length compared with 8.5 to 10.6 percent for *ocellatus*), and by the usually present solid black blotch centrally located on the ocular side (in *ocellatus* this centrally-located blotch is bordered with white).

Additional Distinguishing Characters: Dorsal rays 62 to 70; anal rays 43 to 49; pectoral rays 9 to 11; total gill rakers 12 to 17; pored lateral line scales 83 to 98; total vertebrae 34 to 36, precaudal vertebrae 12 to 13, caudal vertebrae 22 to 24; anterior branch of accessory dorsal lateral line present on all specimens; posterior branch of accessory dorsal lateral line reaches base of dorsal ray 29 to 39.

Color: When fresh, dull greyish-green on ocular side of body. A dark blotch frequently present at approximate mid-body, exclusive of caudal, sometimes a smaller blotch a head length behind this. Other dark blotches sometimes along dorsal and ventral body contours, near bases of both dorsal and anal fin rays, one head length in advance of posteriormost rays.

Distribution: Santa Barbara, California, south to Magdalena Bay, Baja California.

Spawning: Ripe females in spawning condition were noted in trawl catches from November through April. Observations are too scanty for drawing conclusions during other months.

Maximum Size: The largest of 1,416 specimens measured and weighed was 295 mm. total length. This individual, a ripe female taken in March 1957, near Long Beach, California, weighed slightly less than a 328-gram *ritteri* that was 10 mm. shorter.

Food: Five of 28 stomachs examined were empty and two others contained amorphous material. Of those with food, 12 contained only polychaete worms, 2 contained only clam parts, and 7 had primarily polychaetes (more than 50 percent by volume) plus other animal matter in them (6 of the 7 had clam siphon tips, and 2 of the 7 contained amphipods).

Depth Distribution: Adult *ritteri* have been caught in water as shallow as 1½ fathoms and as deep as 25. Most, however, are captured in 10 fathoms or less.

Sex Ratios: Twenty-five percent (358) of 1,410 specimens sexed were males.

Material Examined: In all, I examined and identified 1,416 specimens of *ritteri*: 939 from Californian waters, and 477 from off Baja California as far south as Magdalena Bay.

Synonymy:

Pleuronichthys ritteri: Starks and Morris, Univ. Calif. Publ. Zool., 3, 1907:243-244 (type descr., type loc. San Diego, cotypes S. D. and S. Pedro, fig.); Starks and

Thompson, Proc. U.S. Natl. Mus., 38 (1744) 1910:277-287 (tax., anat., color, size, S. Pedro south); Metz, Ann. Rept. Laguna Mar. Lab., 1, 1912:60 (common near Newport); Gilbert, Proc. U.S. Natl. Mus., 48, 1915:378 (off San Diego 25 fms.); Hubbs, Univ. Calif. Publ. Zool., 16, 1916:169 (size, color, San Pedro, La Jolla); Starks, Calif. Fish and Game, 4, 1918:165, 172-173 (tax., anat., color, size, distrib., fig.); Fowler, Proc. Acad. Nat. Sci. Phila., 75, 1923:297 (La Jolla); Ulrey and Greeley, Bull. So. Calif. Acad. Sci., 28(1) 1928:32 (records); Ulrey, J. Pan-Pac. Res. Inst., 4(4) 1929:5 (So. Calif.); Jordan, Evermann, and Clark, Rep. U.S. Comm. Fish., 1930:225 (San Diego Bay); Walford, Calif. Div. Fish and Game, Fish Bull. 28, 1931:18 (common name, distrib.); Norman, Monograph of flatfishes 1, 1934:318, 324-325 (tax., syn., rel., anat., color, size, distrib., fig.); Barnhart, Marine fishes southern Calif., 1936:28, 30 (tax., anat., color, size, localities, fig.); Roedel, Calif. Div. Fish and Game, Fish Bull. 68, 1948:12, 24 (common name, characters); McCully, Calif. Fish and Game, 35(1):1949:13 (field key); Clothier, Calif. Div. Fish and Game, Fish Bull. 79, 1950:25-27, 45 (vert. characters, San Diego); Cannon, How to Fish Pac. Coast, 1953:228-229 (names, characters, size, color, range, fishing tackle, fig.); Roedel, Calif. Dept. Fish and Game, Fish Bull. 91, 1953:69 (common name, range, characters); Berdegue, Sect. Mar. Mexico, 1956: 315 (listed, Baja California); Miller, Calif. Dept. Fish and Game, Field Guide 1, 1959:26-27 (characters, distrib., illus. key).

Gulf turbot, *Pleuronichthys ocellatus* Starks and Thompson, 1910

Differential Diagnosis: May be distinguished from all species of *Pleuronichthys* except *ritteri* by its low vertebral (total) count (*ocellatus* has 34 or 35 total vertebrae whereas all others except *ritteri* have 36 to 41 vertebrae). May be distinguished from *ritteri* by its larger bony upper orbit (8.5 to 10.9 percent of standard length in *ocellatus*, 6.3 to 8.1 in *ritteri*), by its longer interorbital ridge measured from the first to third protuberance (8.5 to 10.6 percent of standard length in *ocellatus*, 5.8 to 7.7 percent in *ritteri*, and by the usually present, white-bordered black blotch, centrally located on the ocular side (*ritteri* may have a centrally-located black blotch but it is never bordered with white).

Additional Distinguishing Characters: Dorsal rays 62 to 74; anal rays 44 to 53; pectoral rays 10 to 12; total gill rakers 10 to 14; pored lateral line scales 84 to 90; total vertebrae 34 to 35, precaudal vertebrae 12 to 13, caudal vertebrae 22 to 23; anterior branch of accessory dorsal lateral line present on all specimens; posterior branch of accessory dorsal lateral line reaches base of dorsal ray 33 to 44.

Color: When fresh, uniform light brown or yellowish-brown on ocular side. A dark blotch ringed with white is usually present at approximate mid-body, excluding caudal fin, on eyed side. A dark blotch on the body near both the dorsal and anal fin ray bases about a head length in advance of their posteriormost rays.

Distribution: Upper half of Gulf of California, from about Concepcion Bay and Guaymas, northward.

Spawning: Females were ripe and apparently capable of spawning from November through March. Observations were too scanty to be useful during other months.

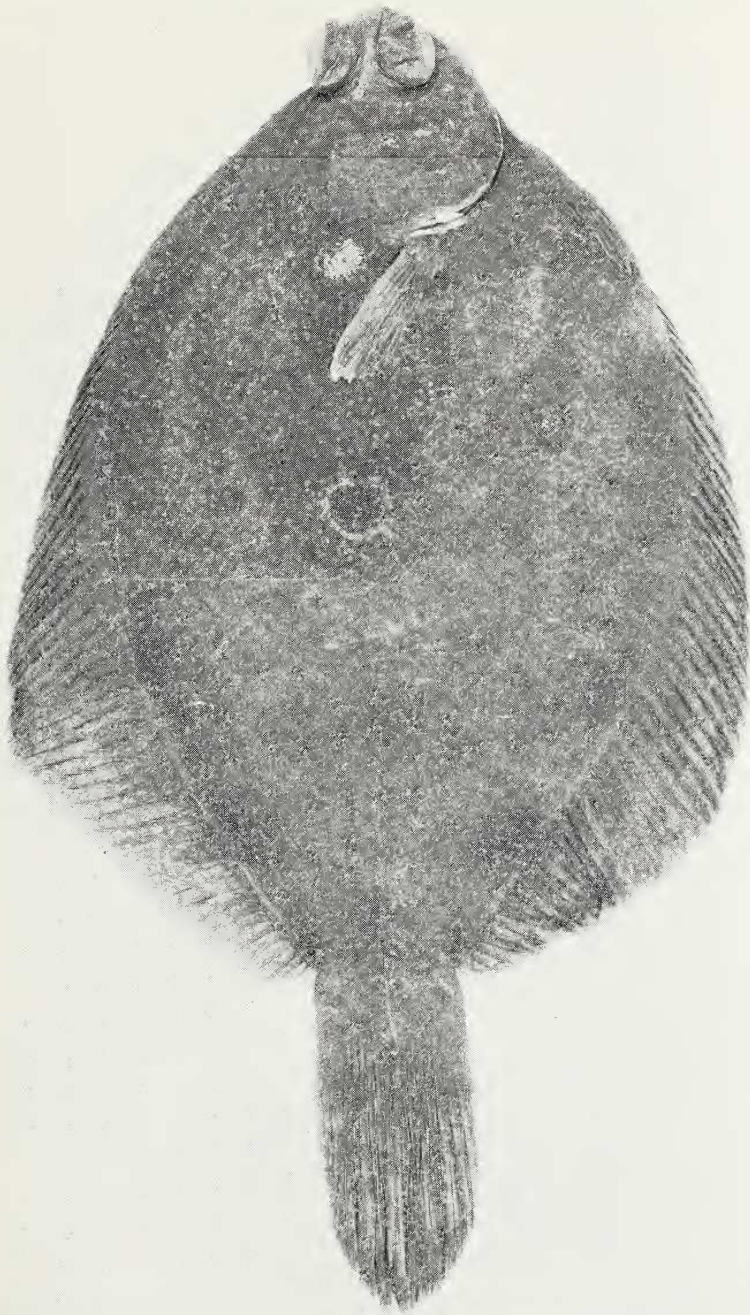


Figure 6. Gulf turbot, *Pleuronichthys ocellatus*, 113 mm.s.l., 142 mm.t.l., collected off San Luis Gonzaga, Baja California, February, 1960. Photograph by Jack W. Schott.

Maximum Size: The largest *ocellatus* encountered was a male 184 mm. standard length (239 mm. total) weighing 170 grams. It was caught in a gill net in 5 fathoms off San Francisquito, Gulf of California.

Food: One of 10 stomachs examined was empty. Six of the remaining 9 contained polychaet worms, amphipods, and clam siphon tips and the other 3 contained clam siphon tips exclusively.

Depth Distribution: Captured in water 3 feet deep near shore and trawled in 73 fathoms, well offshore.

Sex Ratios: Half of 16 specimens checked for sex were males.

Material Examined: I examined and identified 191 specimens of *ocellatus*, all from the Gulf of California, Concepcion Bay north to San Felipe and Guaymas north to Pt. Peñasco. Included in the material examined were the holotype (USNM 74605) and eight paratypes (SU 198 and 5369).

Synonymy:

Pleuronichthys ocellatus: Starks and Thompson, Proc. U.S. Natl. Mus., 38 (1744) 1910:277-287 (type descr., tax., syn., characters, color, Gulf of Calif. deep water, fig.); Norman, Monograph of flatfishes, 1, 1934:318, 325:326 (tax., syn., key, descr., characters, color, fig.); Breder, Bull. Bing. Oceanogr. Coll., 2(3) 1936:4 (misprint "Gonzago" Bay, Concepcion Bay); Fowler, Monogr., Acad. Nat. Sci. Phila., 6, 1944:495 (listed, Gulf of California); Berdegue, Sect. Mar. Mex., 1956:315 (listed).

C-O turbot, *Pleuronichthys coenosus* Girard, 1856

Differential Diagnosis: May be distinguished from *verticalis* and *cornutus* by having teeth in its lower jaw on the ocular side (*verticalis* and *cornutus* have none) and by its lack of a sharp projecting spine on the posterior end of the interorbital ridge. It can be distinguished from *decurrens* by having an anterior branch to the dorsal accessory lateral line and by its more dorsally inserted dorsal fin (level with snout in *coenosus*, opposite lower corner of mouth in *decurrens*). Distinguished from *ritteri* and *ocellatus* by its greater number of total vertebrae (37 to 39 in *coenosus*, compared with 34 to 36 in *ritteri* and *ocellatus*).

P. nephelus (Starks and Thompson, 1910) was placed in synonymy of *P. coenosus* by Hubbs (1928) who said he could, "find no grounds for the separation of the nominal Puget Sound species *P. nephelus*." I was unable to distinguish the type material of *nephelus* from *coenosus* either by fin ray counts or by scale counts, characters used by Starks and Thompson to differentiate *nephelus*. Furthermore, all other characters I investigated on *nephelus* fitted comfortably within the ranges of variation determined for *coenosus* (Tables 2-4).

Additional Distinguishing Characters: Dorsal rays 66 to 77; anal rays 46 to 55; pectoral rays 9 to 12; total gill rakers 11 to 15; pored lateral line scales 77 to 92; total vertebrae 37 to 39, precaudal vertebrae 12 to 13, caudal vertebrae 24 to 26; anterior branch of accessory dorsal lateral line always present; posterior branch of accessory dorsal lateral line reaches base of rays 29 to 44 on ocular side; adults nearly all with dusky blotches on blind side of body.

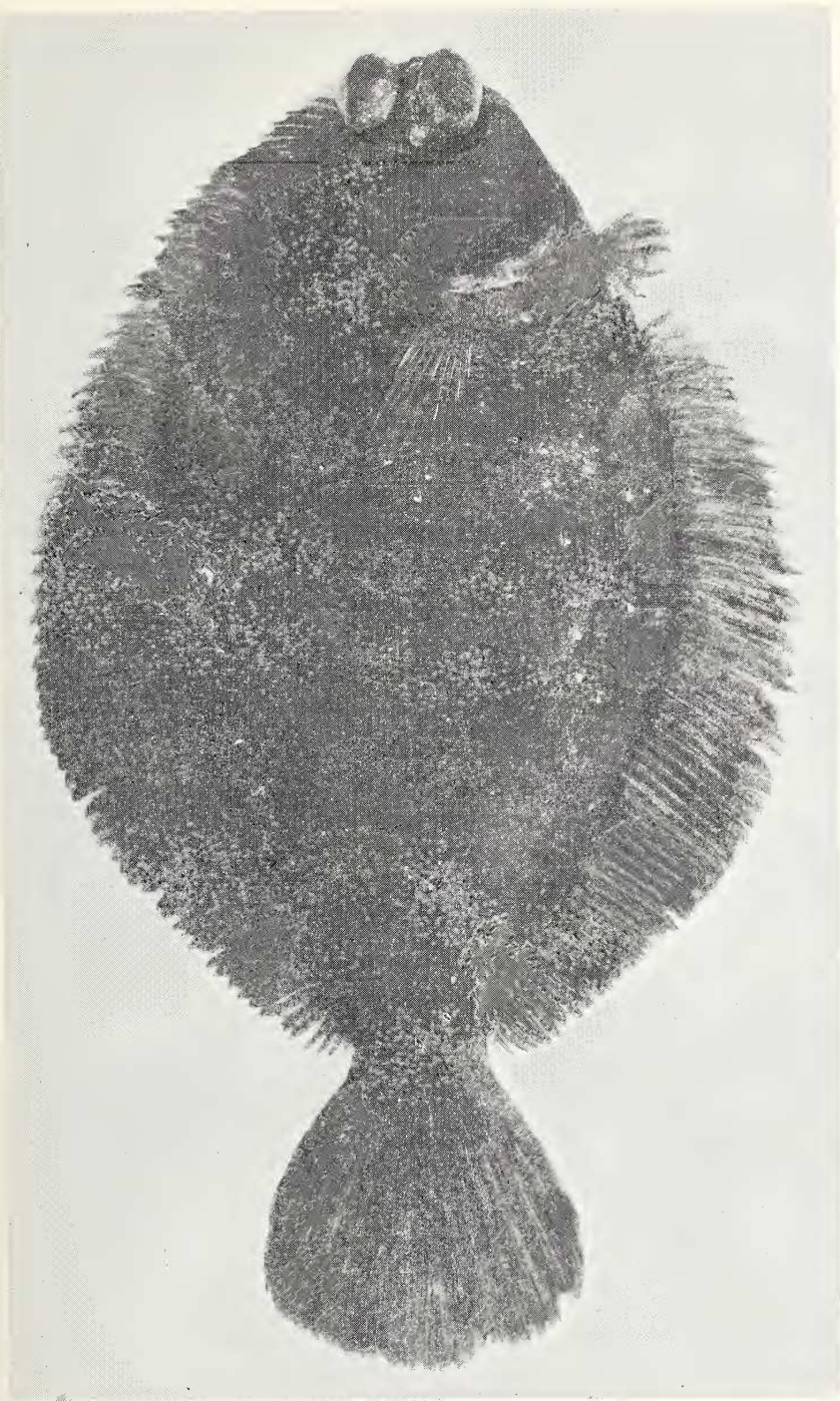


Figure 7. C-O turbot, *Pleuronichthys coenosus*, 210 mm.s.l., 270 mm.t.l., collected off Seal Beach, California, November 13, 1956. Photograph by Jack W. Schott.

Color: When fresh, body and fins brownish-green, occasionally a brownish or yellowish-brown blotch at center of body on ocular side. Various intensities of basic colors give marbled appearance to body and fins. Caudal often marked with central dusky blotch partially encircled anteriorly with a dusky C-shaped bar, especially easy to see on live (aquarium) fish. Blind side often with dusky blotches in adults.

Distribution: Alaska south to Cape Colnett, Baja California

Spawning: Females with transparent eggs in their ovaries have been taken during every month of the year; however, most spawning appears to take place from about May through September. Budd (1940) found their fertilized eggs in plankton tows made off Monterey during November and April.

Eggs: Their eggs closely resemble those of *verticalis* and *decurrens* in all respects except size, being 1.88 mm. in average diameter (Budd, 1940). Hatching was estimated to occur 12 days (280 hours) after fertilization.

Larvae: The greatly increased length of the incubation period has a marked effect on the larva which is large, well-developed, extremely active, and able to swim about at will immediately after hatching (Budd, 1940). It is comparable in its degree of organization to the week-old larva of *verticalis*. A newly hatched *coenosus* larva was 5.54 mm. in standard length, had a well-formed head, and large, functional jaws. The entire body is heavily pigmented as is the rectum. Budd was unable to carry *coenosus* larvae beyond eight days, during which time they changed very little.

Maximum Size: The largest *coenosus* encountered among 585 measured was 333 mm. total length. It was trawled in 10 fathoms in Santa Monica Bay on May 10, 1961. A slightly smaller individual, at 431 grams, was the heaviest noted.

Food: Two of 10 stomachs examined were empty, 5 contained polychaet worms (1 exclusively), 5 contained clam parts, particularly siphons (1 exclusively), 1 contained the remains of a two-inch rockfish, *Sebastes* sp., 1 an amphipod, and 1 had several nudibranchs and tectibranchs in it.

Depth Distribution: Seldom encountered in water shallower than 5 fathoms and seldom deeper than 30. I was able to find a single record of *coenosus* from 35 fathoms, but none deeper.

Sex Ratios: Forty percent (188) of 470 specimens sexed were males. Individuals were examined during every month of the year but there were no noticeable differences in this ratio. Females tended to be somewhat larger than males.

Material Examined: In all, 585 specimens of *coenosus* were examined and identified. Six of these, the holotype (USNM 74606) and 7 paratypes (SU 21414) of *nepheus* (= *coenosus*), were from San Juan Island, Puget Sound; 486 were from California waters; and 90 were from off Baja California, as far south as Cape Colnett.

Synonymy:

Pleuronichthys coenosus: Girard, Proc. Acad. Nat. Sci. Phila., 7, 1854:139

(type descr., San Francisco); Jordan and Gilbert, Proc. U.S. Natl. Mus., 3, 1880:50 (key characters, Santa "Catilina" Isl., San Luis Obispo); Smith, List fishes San Diego, Calif., 1880:no page ("*caenosus*" common San Diego); Jordan and Gilbert, Proc. U.S. Natl. Mus., 4:1881:68 (ecol., food, life-hist., size, San Diego-north); Jordan and Jouy, Proc. U.S. Natl. Mus., 4 1881:2 (Santa Catalina Isl., Wilmington, San Diego, Monterey, San Francisco); Eigenmann, Proc. U.S. Natl. Mus., 15, 1892:128-131, 174-176 (life-hist., egg, syn., abundant San Diego Bay); Jordan and Evermann, Bull. U.S. Natl. Mus., 47(3) 1898:2637-2639 (tax., anat., color, syn., San Diego north); Starks and Morris, Univ. Calif. Publ. Zool., 3, 1907:243 (Calif. distrib.); Starks and Thompson, Proc. U.S. Natl. Mus., 38 (1744) 1910:277-287 (tax., anat., color, size, key characters, San Francisco to San Pedro); Hubbs, Univ. Calif. Publ. Zool., 16, 1916:169 (La Jolla); Starks, Calif. Fish and Game, 4, 1918:171-173 (tax., anat., color, fig., size, common entire Calif. coast); Fowler, Proc. Acad. Nat. Sci. Phila., 75, 1923:288 (Pt. Firmin); Hubbs Jour. Pan-Pac. Res. Inst., 3(3) 1928:16 (listed, Oregon, Wash., *P. nephelus* a synonym); Ulrey and Greeley, Bull. So. Calif. Acad. Sci., 28(1) 1928:31 (San Diego north); Ulrey, J. Pan-Pac. Res. Inst. 4(4) 1929:5 (So. Calif.); Jordan, Evermann, and Clark, Rep. U.S. Comm. Fish., 1930:225 (San Diego north); Walford, Calif. Div. Fish and Game, Fish Bull. 28, 1931:18 (tax., Calif. distrib.); Norman, Monogr. of flatfishes, 1, 1934:317-326 (tax., key, synon., anat., color, size, fig., Calif. coast); Barnhart, Marine fishes southern Calif., 1936:28-30 (tax., anat., color, size, fig., So. Calif. north); Schultz, Univ. Wash., Publ. Biol. 2(4) 1936:158 (tax., common San Diego north); Schultz and DeLacy, Mid-Pac. Mag., 49(1) 1936:67-68 (syn., refs., Wash. records, Alaska to San Diego); Schultz and DeLacy, Mid-Pac. Mag., 49(3) 1936:212 (refs., *P. nephelus* a synonym); Townsend, Rept. Int. Fish. Comm., 11, 1936:9-10 (vert. characters); Budd, Calif. Div. Fish and Game, Fish Bull. 56, 1940:33-37 (spawning, eggs and larvae figured, Monterey); Clemens and Wilby, Bull. Fish. Res. Bd. Canada, 68, 1946:320-321 (characters, size, Brit. Col. records, fishery, range, fig.); Roedel, Calif. Div. Fish and Game, Fish Bull. 68, 1948:12, 24 (common name, distrib., characters); McCully Calif. Fish and Game, 35(1) 1949:13 (field key); Clothier, Calif. Div. Fish and Game, Fish Bull. 79, 1950:25, 26, 27, 45 (vert. key and characters, Santa Barbara, Gaviota); Cannon, How to Fish Pac. Coast, 1953:226-228 (names, characters, size, color, range, fishing tackle, fig.); Roedel, Calif. Dept. Fish and Game, Fish Bull. 91, 1953:69 (common name, distrib., characters); Wilimovsky, Stan. Ich. Bull., 4(5) 1954:283 (listed, southeast Alaska); Miller, Calif. Dept. Fish and Game, Field Guide 1, 1959:26-27 (characters, distrib., illus. key); Clemens and Wilby, Bull. Fish. Res. Bd. Canada, rev. edit., 68:1961:192-193 (common name, tax., characters, size, Brit. Col. records, distrib.).

Pleuronichthys nephelus: Starks and Thompson, Proc. U.S. Natl. Mus., 38 (1744) 1910:277-287 (type descr., key, fig., Puget Sound); Kincaid, Wash. Dept. Fish., 1919:51 (characters, color, size, Puget Sound); Hubbs, J. Pan-Pac. Res. Inst., 3(3) 1928:16 (synonym of *P. coenosus*); Norman, Monogr. of flatfishes, 1, 1934:317-326 (tax., key, anat., color, size, fig., Puget Sound); Schultz and DeLacy, Mid. Pac. Mag., 49(3) 1936:212 (synonym of *P. coenosus*).

Parophrys coenosa: Günther, Cat. fishes Brit. Mus., 4, 1862:456 (synon., copied descr.).

Pleuronectes quadrituberculatus: Jordan and Gilbert, Proc. U.S. Natl. Mus., 3, 1880:50 (synonym of *Pleuronichthys quadrituberculatus*).

ACKNOWLEDGMENTS

It would be difficult to find enough space to mention all the people who should be thanked for having assisted me since I started working on this

group of fishes in 1955. A number of individuals were especially helpful and I should like to express my appreciation to these persons by name.

Elbert H. Ahlstrom, U.S. Bureau of Commercial Fisheries, La Jolla, furnished information regarding use of the caudal complex for identifying pleuronectids; W. I. Follett, California Academy of Sciences, San Francisco, assisted with synonymies for the Californian species; Carl L. Hubbs, Scripps Institution of Oceanography, La Jolla, loaned me specimens of *ocellatus*; Robert R. Miller, University of Michigan loaned me specimens of *cornutus*; George S. Myers, Stanford University (SU), loaned me paratypes of *ocellatus* and *nephelus*, and specimens of the Asiatic *cornutus*; Leonard P. Schultz, U.S. National Museum (USNM), loaned me X-rays of the holotypes of *ocellatus* and *cornutus*; and Boyd W. Walker, University of California, Los Angeles, loaned me specimens of *ocellatus* and offered much-needed advice and criticism during various stages of my research; John Bollinger and Keith Radford, Scripps Institution of Oceanography, X-rayed numerous specimens of *cornutus*, *ocellatus*, and "*nephelus*" for me.

In addition, numerous associates at California State Fisheries Laboratory were always willing to lend a hand: John L. Baxter, Leo Pinkas, and Parke H. Young assisted greatly in collecting and processing material; Jack W. Schott took all of the photographs of *Pleuronichthys*; Mrs. P. Patricia Powell checked a number of my references for accuracy; and Mrs. Loretta Morris typed the manuscript and put it into presentable form.

To all of these, as well as any others I have inadvertently omitted, I offer my heartfelt thanks.

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